Adaptivity and Personalization in Learning Systems

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Adaptivity and Personalization in Learning Systems

How can we make learning systems more adaptive, intelligent and personalized

- Based on a comprehensive student model that combines learner information and context information
- In different settings such as desktop-based, mobile and ubiquitous settings
- In different situations such as for formal, informal and non-formal learning
- Supporting learners as well as teachers
- Develop approaches, add-ons and mechanisms that extend existing learning systems
Adaptivity and Personalization in Learning Systems

- Students’ characteristics
  - Learning styles
  - Cognitive traits
  - Context information (environmental context & device functionalities)
  - Motivational aspects
  - Affective states

- Different settings
  - Learning management systems
  - Mobile / Ubiquitous learning
Adaptivity and Personalization in Learning Systems

- Students’ characteristics
  - Learning styles
  - Cognitive traits
  - Context information (environmental context & device functionalities)
  - Motivational aspects
  - Affective states

- Different settings
  - Learning management systems
  - Mobile / Ubiquitous learning
Adaptivity based on Learning Styles

- In order to provide adaptivity, two steps are required:
  - Identifying students’ characteristics
  - Use the information about students’ characteristics to provide them with adaptive courses

- Focus on extending learning management systems
  - Because these systems are typically used by educational institutions

- Focus on learning styles
  - Because it has high potential to support learners
  - Felder-Silverman learning style model
Automatic Identification of Learning Styles
Automatic Identification of Learning Styles

- Learning styles questionnaires have several disadvantages (e.g., students don’t like them, non-intentional influences, can be done only once)

- Automatic modelling
  - What are students really doing in an online course?
  - Infer their learning styles from learners’ behaviour

- Benefits of automatic student modelling
  - No additional effort for students
  - More accurate results

- General Goal
  - Developing an approach for learning systems in general
  - Implementing and evaluating this approach in Moodle
  - Developing a tool which can be used by teachers in order to identify students’ learning styles
Automatic Identification of Learning Styles

- Identifying learning styles is based on patterns of behaviour.
- Commonly used types of learning objects were used (Content objects, Outlines, Examples, Self-assessment tests, Exercises, Discussion forum) and relevant patterns were derived from these types of learning objects.
- Overall, 27 patterns were used for the four learning style dimensions.
- Calculation of learning styles is based on hints from patterns.
- A simple rule-based mechanism is used for this calculation (currently investigating the use of neural networks in combination with particle swarm optimization).
## Determining Relevant Behaviour

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Evaluation

- Study with 75 students
  - Let them fill out the ILS questionnaire
  - Tracked their behaviour in an online course
- Using a measure of precision
  \[
  \text{Precision} = \frac{\sum_{i=1}^{n} \text{Sim}(\text{LS}_{\text{predicted}}, \text{LS}_{\text{ILS}})}{n}
  \]
- Looking at the difference between results from ILS and automatic approach

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→ suitable instrument for identifying learning styles
Tool for Identifying Learning Styles

- Developed a stand-alone tool for identifying learning styles in learning systems
Adaptive Mechanism for Providing Advanced Adaptivity based on Learning Styles
Adaptive Course Provision based on Learning Styles

- Develop a mechanism that enables learning systems to automatically generate adaptive courses

- General goals:
  - Mechanism should be applicable for different learning systems
  - Mechanism should ask teachers for as little as possible additional effort

- Benefits:
  - Teachers can continue using their courses in existing learning systems
  - Students get personalized support with respect to their learning styles
Adaptive Course Provision

- Incorporates only common types of learning objects
  - Content
  - Outlines
  - Conclusions
  - Examples
  - Self-assessment tests
  - Exercises

- Adaptation Features
  - Adaptive sequencing of examples, exercises, self-assessment tests, outlines and conclusions
  - Adapting the number of examples and exercises

- Teachers have to:
  - Provide learning objects
  - Annotate learning objects (distinguish between the objects)
Evaluation of the Concept

- Implemented add-on for Moodle
- Evaluated with 437 students participating in a course about object-oriented modelling
- Results show:
  - Matched Group: less time and equal grades
  - Mismatched Group: ask more often for additional learning objects

→ Demonstrates positive effect of adaptivity
Extension of adaptive mechanism

Make adaptive mechanism more generic and easy to apply for different types of courses

- Added more types of learning objects (overall 12)
- Having as little restrictions as possible for teachers
  - Teachers can add many different types of learning objects (LOs) in their courses
  - Teachers can add types of LOs wherever they feel they fit (as they usually do in LMSs)
  - Teachers do not have to add types of LOs
  - However, the more LOs are available in the course, the more adaptivity can be provided
- Added adaptive annotations
Demo

Demo ...
Current/Future Work on Adaptivity based on Learning Styles

- Using **dynamic** student modelling for more accurate identification and frequent updates in adaptivity
- Developing a mechanism that analyses course content/activities and students’ learning styles and then provides **recommendations to teachers**
- Providing adaptive courses in **mobile** environments
Considering Cognitive Abilities, Motivational Aspects and Context in Learning Systems
Considering Cognitive Abilities in Learning Management Systems

- Cognitive abilities are essential for learning and include, for example,
  - Working Memory Capacity
  - Inductive Reasoning Ability
  - Information Processing Speed
  - Associative Learning Skills
  - Etc.

- Automatic identification of cognitive abilities in learning systems

- Automatic provision of adaptive courses based on students’ cognitive abilities (in combination with learning styles)
Motivational Aspects in LMSs

- Motivation is a key factor in education
- Different learners are motivated differently
- Our research aims at:
  - extending LMSs with motivational techniques which are domain-independent and course-independent
    - Examples:
      - Goal setting
      - Progress timeline & progress annotations
      - Ranking
      - Awards & award levels
      - ...
    - Enable systems to identify preferred motivational techniques, in particular situations
    - Enable systems to provide personalized motivational techniques
Considering Learners’ Environmental Context

- Due to the recent advances in mobile technologies, learners can learn anywhere.

- Our research aims at:
  - Enabling mobile systems to know the learners’ environment and provide him/her with learning objects/activities that work best in such environments.
  - Investigating the use of different sensors (e.g., microphone, GPS, camera, etc.) to get a comprehensive context model, including, for example,
    - Whether a learner is in a silent or noisy environment
    - Whether a learner is alone or in a group
    - Whether a learner is at a particular place or moving (e.g., in a bus)
    - etc.
  - Provide learners with adaptive recommendations based on his/her context, considering individual and community-based data.
Questions

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